On the other hand, it is desirable that the pinned magnetic layer 144 above the antiferromagnetic film is completely removed and the longitudinal bias layers are formed directly on the antiferromagnetic film. The reason is because, as will be mentioned hereunder, the magnetization direction of the pinned magnetic layer 144 must be perpendicular to that of the longitudinal bias layers 15. If so, the magnetization of the longitudinal bias layers 15 will be unstable owing to the magnetic interaction between the pinned magnetic layer 144 and the overlying longitudinal bias layers 15. Alternatively, the etching removal may reach the high-conductivity layer 147 but not the free layer, and the longitudinal bias layers may be formed on the remaining free layer.

For improving the crystallinity of the layers, or for attenuating the magnetic coupling force between the antiferromagnetic layer 143 and the longitudinal bias layers 15, an extremely thin underlayer 153 (this may be the same as the underlayer 142) may be disposed below the ferromagnetic layer 151. Even though thin, a nonmagnetic layer existing between ferromagnetic layers will readily make the ferromagnetic layers coupled magnetically to each other. As opposed to this, in the combination of an antiferromagnetic layer and a ferromagnetic layer, a nonmagnetic layer existing therebetween, even though thin, cancels the magnetic coupling of the antiferromagnetic layer and the ferromagnetic layer.

In order to effectively apply the bias magnetic field from the longitudinal bias layers to the free layer, the thickness of the underlayer 153 is preferably at most 10 nanometers. For the hard magnetic film, it is also desirable that the saturation magnetization of the hard magnetic film is comparable to that of the free layer. However, in general, it is difficult to prepare hard magnetic films with high saturation magnetization of which the saturation magnetization is comparable to that of free layers of CoFe or the like with high saturation magnetization.

Therefore, it is desirable that a underlayer of FeCo or the like with high saturation magnetization, of which the saturation magnetization is comparable to that of CoFe, is formed below the hard magnetic film to thereby keep good balance of saturation magnetization between the hard magnetic film and the free layer, for the purpose of removing BHN in a weak longitudinal bias magnetic field. The antiferromagnetic materials for the antiferromagnetic film 152 may be the same as those for the spin valve film.

However, the magnetic coupling bias direction of the antiferromagnetic layer of the spin valve film must be perpendicular to that of the antiferromagnetic film 152 of the longitudinal bias layer. (The magnetic coupling bias direction of the antiferromagnetic layer of the spin valve film is in the device width (height) direction, while that of the

antiferromagnetic film 152 of the longitudinal bias layer is in the track width direction.)

For example, the two antiferromagnetic films are made to have different blocking temperatures Tb. First, the magnetic coupling bias direction of one antiferromagnetic film having a higher Tb is pinned through thermal treatment, and thereafter Tb of the other antiferromagnetic film is defined to be around a temperature at which the magnetization direction of the ferromagnetic film (this is pinned by the magnetic coupling bias of the antiferromagnetic film whose Tb has been previously defined) is stable and which is lower than the temperature for the previous thermal treatment, whereby the magnetic coupling bias directions of the two antiferromagnetic films could be perpendicular to each other. For the magnetic coupling bias application to the antiferromagnetic layer 152, preferably used is a film-forming method in a magnetic field (in which is used IrMn, RhMn or the like), or a resist-curing thermal treatment method at 200 to 250°C such as that for forming a recording region (in which is used PtMn, PdPtMn, IrMn or the like). For the antiferromagnetic layer of the spin valve film, an antiferromagnetic film having a higher Tb (e.g., IrMn, PtMn, PdPtMn, etc.) may be used. In that case, the magnetic coupling bias direction of the antiferromagnetic film 152 could be pinned in the track width direction according to the resist-curing thermal treatment method, without disturbing